Amendments to the Specification:

Please replace the title with the following amended title:

~~METHOD OF MAKING A COATED~~ STRUCTURED ABRASIVE ARTICLE

Please replace the fourteen paragraphs beginning on page 2, line 15 with the following amended paragraphs:

FIG. 1 is a cross-section view, enlarged, ~~representing another~~ of an abrasive article according to an embodiment of this invention.[[;]]

FIG. 2 is a schematic of a process [[of]] for making the abrasive article of **FIG. 1**. ~~; and~~

FIG. 3 is a schematic of another process [[of]] for making the abrasive article of **FIG. 1**.

FIG. 4A depicts a top view of a protruding unit of an abrasive article in accordance with an embodiment of the present invention.

FIG. 4B depicts a top view of ~~a protruding unit~~ an abrasive article in accordance with an embodiment of the present invention.

FIG. 4C depicts a top view of ~~an~~ another abrasive article in accordance with an embodiment of the present invention.

FIG. 4D depicts another top view of a protruding unit of an abrasive article in accordance with an embodiment of the present invention.

FIG. 4E depicts another top view of a protruding unit of an abrasive article in accordance with an embodiment of the present invention.

FIG. 4F depicts another top view of a protruding unit in accordance with an embodiment of the present invention.

FIG. 4G depicts another top view of a protruding unit of an abrasive article in accordance with an embodiment of the present invention.

FIG. 4H depicts another top view of a protruding unit of an abrasive article in accordance with an embodiment of the present invention.

FIG. 5 depicts a perspective view of another abrasive article in accordance with an embodiment of the present invention.

FIG. 6A depicts a top view of an array of protruding units of an abrasive article in accordance with an embodiment of the present invention.

FIG. 6B depicts a top view of another array of protruding units of an abrasive article in accordance with an embodiment of the present invention.

Please replace the paragraph beginning on page 5, line 17, with the following amended paragraph:

Referring to **FIG. 1**, the abrasive article **20** comprises abrasive composites **22** separated by boundary **25**. The abrasive composites are bonded to a surface of a backing **21**. The boundary or boundaries associated with the composite shape result in one abrasive composite being separated to some degree from another adjacent abrasive composite. To form an individual abrasive composite, a portion of the boundaries forming the shape of the abrasive composite must be separated from one another. Note that in **FIG.** [[2]] **1**, the base or a portion of the abrasive composite closest to the backing can abut with its neighboring abrasive composite. Abrasive composites **22** comprise a plurality of abrasive particles **24** and grinding aid **26** that are dispersed in a binder **23**~~**and a grinding aid 26**~~. It is also within the scope of this invention to have a combination of abrasive composites bonded to a backing in which some of the abrasive composites abut, while other abrasive composites have open spaces between them.

Please replace the paragraph beginning on page 8, line 28, with the following amended paragraph:

Ethylenically unsaturated compounds preferably have a molecular weight of less than about 4,000 and are preferably esters made from the reaction of compounds containing aliphatic monohydroxy groups or aliphatic polyhydroxy groups and unsaturated carboxylic acids, such as acrylic acid, methacrylic acid, itaconic acid, crotonic acid, isocrotonic acid, maleic acid, and the like. Representative examples of acrylate resins include methyl methacrylate, ethyl methacrylate styrene, divinylbenzene, vinyl toluene, ethylene glycol diacrylate, ethylene glycol methacrylate,

hexanediol diacrylate, triethylene glycol diacrylate, trimethylolpropane triacrylate, glycerol triacrylate, pentaerythritol triacrylate, pentaerythritol methacrylate, pentaerythritol tetraacrylate and pentaerythritol tetraacrylate. Other ethylenically unsaturated resins include monoallyl, polyallyl, and polymethallyl esters and amides of carboxylic acids, such as diallyl phthalate, diallyl adipate, and ~~N,N-diallyladkipamide~~ N,N-diallyladipamide. Still other nitrogen containing compounds include tris(2-acryloyloxyethyl)isocyanurate, ~~1,3,5-tri(2-methyacryloxyethyl)-triazine~~ 1,3,5-tri(2-methylacryloxyethyl)-triazine, acrylamide, methylacrylamide, N-methylacrylamide, N,N-dimethylacrylamide, N-vinylpyrrolidone, and N-vinylpiperidone.

Please replace the paragraph beginning on page 10, line 1, with the following amended paragraph:

Epoxy resins have an oxirane and are polymerized by the ring opening. Such epoxide resins include monomeric epoxy resins and oligomeric epoxy resins. Examples of some preferred epoxy resins include 2,2-bis[4-(2,3-epoxypropoxy)-phenyl propane] (diglycidyl ether of bisphenol) and commercially available materials under the trade designations "Epon 828", "Epon 1004", and "Epon 1001F" available from Shell Chemical Co., and "DER-331", "DER-332", and "DER-334" available from Dow Chemical Co. Other suitable epoxy resins include glycidyl ethers of phenol formaldehyde novolac (e.g., "DEN-431" and "DEN-428" available from Dow ~~chemical~~ Chemical Co.).

Please replace the paragraph beginning on page 12, line 16, with the following amended paragraph:

Referring to **FIG. 1**, the abrasive article **10** comprises abrasive composites **22** separated by boundary **25**. The boundary or boundaries associated with the composite shape result in one abrasive composite being separated to some degree from another adjacent abrasive composite. To form an individual abrasive composite, a portion of the boundaries forming the shape of the abrasive composite must be separated from one another. Note that in **FIG. 1**, the base or a portion of the abrasive composite closest to the backing can abut with its neighboring abrasive composite. Abrasive composites **22** comprise a plurality of abrasive particles **24** and grinding

aid **26** that are dispersed in a binder **23** ~~and a grinding aid **26**~~. It is also within the scope of this invention to have a combination of abrasive composites bonded to a backing in which some of the abrasive composites abut, while other abrasive composites have open spaces between them.

Please replace the paragraph beginning on page 14, line 22, with the following amended paragraph:

In another aspect of this invention, a portion of the abrasive composites ~~have~~ has a neighboring abrasive composite of a different dimension. In this aspect of the invention, at least 10%, preferably at least 30%, more preferably at least 50% and most preferably at least 60% of the abrasive composites have an adjacent abrasive composite that has a different dimension. These different dimensions can pertain to the abrasive composite shape, angle between planar boundaries or dimensions of the abrasive composite. The result of these different dimensions for neighboring abrasive composites results in an abrasive article that produces a relatively finer surface finish on the workpiece being abraded or refined. This aspect of the invention is further described in U.S. Patent No. 6,129,540, which claims priority to ~~the assignee's co-pending~~ patent application U.S. Ser. No. 08/120,300 filed Sep. 13, 1993, now abandoned.

Please replace the paragraph beginning on page 15, line 17, with the following amended paragraph:

An essential step to make any of the inventive abrasive articles is to prepare the slurry. The slurry is made by combining together by any suitable mixing technique the binder precursor, the grinding aid, the abrasive particles and ~~the~~ any optional additives. Examples of mixing techniques include low shear and high shear mixing, with high shear mixing being preferred. Ultrasonic energy may also be utilized in combination with the mixing step to lower the abrasive slurry viscosity. Typically, the abrasive particles and grinding aid are gradually added into the binder precursor. The amount of air bubbles in the slurry can be minimized by pulling a vacuum during the mixing step. In some instances it is preferred to heat, generally in the range of 30° to 70° C., the slurry to lower the viscosity. It is important the slurry have ~~theological~~ rheological

properties that allow the slurry to coat well and in which the abrasive particles and grinding aid do not settle out of the slurry.

Please replace the paragraph beginning on page 18, line 1, with the following amended paragraph:

One method to make the abrasive article of the invention ~~illustrated in **FIG. 2**~~ is illustrated in **FIG. 2**. Backing **41** leaves an unwind station **42** and at the same time [[the]] production tool **46** leaves an unwind station **45**. Production tool **46** is coated with slurry by means of coating station **44**. It is possible to heat the slurry and/or subject the slurry to ultrasonics prior to coating to lower the viscosity. The coating station can be any conventional coating means such as drop die coater, knife coater, curtain coater, vacuum die coater or a die coater. During coating the formation of air bubbles should be minimized. The preferred coating technique is a vacuum fluid bearing die, such as disclosed in U.S. Pat. Nos. 3,594,865, 4,959,265, and 5,077,870, all incorporated herein by reference. After the production tool is coated, the backing and the slurry are brought into contact by any means such that the slurry wets the front surface of the backing. In **FIG. 2**, the slurry is brought into contact with the backing by means of contact nip roll **47**. Next, contact nip roll **47** also forces the resulting construction against support drum **43**. A source of energy **48** (preferably a source of visible light) transmits a sufficient amount of energy into the slurry to at least partially cure the binder precursor. The term partial cure is meant that the binder precursor is polymerized to such a state that the slurry does not flow from an inverted test tube. The binder precursor can be fully cured once it is removed from the production tool by any energy source. Following this, the production tool is rewound on mandrel **49** so that the production tool can be reused again. Optionally, the production tool may be removed from the binder precursor prior to any curing of the precursor at all. After removal, the precursor may be cured, and the production tool may be rewound on mandrel **49** for reuse. Additionally, abrasive article **120** is wound on mandrel **121**. If the binder precursor is not fully cured, the binder precursor can then be fully cured by either time and/or exposure to an energy source. Additional steps to make abrasive articles according to this first method are further described in U.S. Pat. No. 5,152,917 and U.S. Pat. No. 5,435,816 ~~Ser. No. 08/004,929, filed Jan. 14, 1993~~, both incorporated herein by reference. Randomly shaped

abrasives composites may be made by the tooling and procedures described in U.S. Patent No. 6,129,549 ~~copending Ser. No. 08/120,300, filed Sep. 13, 1993~~, incorporated herein by reference.

Please replace the paragraph beginning on page 20, line 27, with the following amended paragraph:

The abrasive articles of the invention can be used by hand or used in combination with a machine. At least one or both of the abrasive article and the workpiece is moved relative to the other during grinding. The abrasive article can be converted into a belt, tape roll, disc, sheet, and the like. For belt applications, the two free ends of an abrasive sheet are joined together and a splice is formed. It is also within the scope of this invention to use a spliceless belt like that described in U.S. Patent No. 5,573,619 ~~the assignee's co-pending patent application U.S. Ser. No. 07/919,541, filed Jul. 24, 1992~~, incorporated herein after by reference. Generally the endless abrasive belt traverses over at least one idler roll and a platen or contact wheel. The hardness of the platen or contact wheel is adjusted to obtain the desired rate of cut and workpiece surface finish. The abrasive belt speed depends upon the desired cut rate and surface finish. The belt dimensions can range from about 5 mm to 1,000 mm wide and from about 5 mm to 10,000 mm long. Abrasive tapes are continuous lengths of the abrasive article. They can range in width from about 1 mm to 1,000 mm, generally between 5 mm to 250 mm. The abrasive tapes are usually unwound, traverse over a support pad that forces the tape against the workpiece and then rewound. The abrasive tapes can be continuously feed through the abrading interface and can be indexed. The abrasive disc can range from about 50 mm to 1,000 mm in diameter. Typically abrasive discs are secured to a back-up pad by an attachment means. These abrasive discs can rotate between 100 to 20,000 revolutions per minute, typically between 1,000 to 15,000 revolutions per minute.

Please replace the paragraph beginning on page 21, line 27, with the following amended paragraph:

The protruding units and abrasive articles having protruding units shown in **FIGS. 4A-H**, **5**, and **6A** and **6B**, and the other protruding units discussed herein may be structured from

materials described above, making use of fabrication methods described above. Although **FIGS. 4A-H**, **5**, and **6A** and **6B** do not depict abrasive grains and binder within the protruding units, it is understood that such grains and binder exist, as the protruding units have abrasive grains and binder as a constituent material.

Please replace the paragraph beginning on page 22, line 8, with the following amended paragraph:

As can be seen from **FIG. 4A**, the linear apex **406**, when projected on to a ~~plain~~ plane that is coplanar with the base **401**, extends between oppositely disposed sides of the base **401**. When referring to the projection of an apex, such as apex **406**, on to a ~~plain~~ plane that is coplanar with a base of a protruding unit, the terms "projection of the apex" or "projection of the linear apex" may be used herein. The center points **402, 404** of the oppositely disposed sides between which the projection of the linear apex **406** extends are identified with small hashings. The projection of the linear apex **406** does not extend between the center points of the oppositely disposed sides.

Please replace the paragraph beginning on page 23, line 13, with the following amended paragraph:

The bases that have been presented in **FIGS. 4A**, **4B**, **4C**, **4D**, **4E**, and **4F** have all been in the shape of a square. Such a restriction is not essential. In principle, the base may be any closed shape. For example, the base may be any regular or irregular polygon, may be a parallelogram, rectangle, or any [[for]] form of quadrilateral. The base may be circular or elliptical. The sides of the base may be rectilinear or curvilinear. For example, the protruding unit **428** depicted in **FIG. 4G** has four sides, two of which are curvilinear **430** and **432**. The center point of the oppositely disposed curvilinear sides of the base may be found by dividing the curvilinear sides into two segments, wherein the length of the first segment is equal to the length of the second segment. For example, side **430** has been divided into two segments: segments **AB** and **BC**. Point **B**, the center point, is positioned so that the length of segment **AB** is equal to the length of segment **BC**. One skilled in the art understands that other measures of centrality may

be used to identify the center point of a line that is not rectilinear. Again, the projection of the linear apex **434** extends between oppositely disposed sides **430** and **432**, but not at their respective center points.

Please replace the two paragraphs beginning on page 24, line 24 and extending to page 25, line 21, with the following amended paragraphs:

FIG. 6A depicts an array of protruding units ~~**600-606**~~ **600, 602, 604, 606**. Each of the protruding units ~~**600-606**~~ **600, 602, 604, 606** has an apex ~~**608-614**~~ **608, 610, 612, 614**, respectively, that is substantially in the shape of a point. Any of the linear apexes in any of the preceding examples may be embodied as a point, as opposed to being embodied as a linear segment. Returning the discussion to **FIG. 6A**, in each of the protruding units ~~**600-606**~~ **600, 602, 604, 606**, the apex ~~**608-614**~~ **608, 610, 612, 614** is located remote from the center. The projection of each apex ~~**608-614**~~ **608, 610, 612, 614** defines an offset vector v_1, v_2, v_3, and v_4, respectively, extending from the center and/or center of mass of the respective base to the projection of the apex ~~**608-614**~~ **608, 610, 612, 614**. Notably, the sum of the offset vectors v_1, v_2, v_3, and v_4 does not equal zero. For example, assuming that each of the offset vectors v_1, v_2, v_3, and v_4 is a unit vector, the sum of the vectors is $2y$. For a large array of protruding units, the sum of the offset vectors should not approach a limit of zero as the number of vectors summed together approaches infinity:

$$\lim_{n\to\infty}\left(\sum v_n\right) \neq 0$$

Stated another way, when viewed in totality, the array should exhibit net directionality with respect to the positioning of the apexes ~~**608-614**~~ **608, 610, 612, 614**.

FIG. 6B shows the idea of net proportionality as it applies to protruding units having linear apexes ~~**616-622**~~ **616, 618, 620, 622**. As can be seen from **FIG. 6B**, the projection of the linear apexes ~~**616-622**~~ **616, 618, 620, 622** define an offset vector v_1, v_2, v_3, and v_4 extending from the centers and/or centers of mass of the respective base to the center of the projection of the apexes ~~**616-622**~~ **616, 618, 620, 622**. Once again, for a large array of protruding units, the sum of

the offset vectors should not approach a limit of zero as the number of vectors summed together approaches infinity:

$$\lim_{n\to\infty}(\sum v_n) \neq 0$$

Stated another way, when viewed in totality, the array should exhibit net directionality with respect to the positioning of the apexes ~~608-614~~ **616, 618, 620, 622**.